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New Packaging for Amplifier Slabs

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MEMORANDUM – November 6, 2002

TO: Zygo

FROM: Mike Riley, Chuck Thorsness, Tayyab Suratwala, Rusty Steele, Greg Rogowski

SUBJECT: New Packaging for Amplifier Slabs

Summary
The following memo provides a discussion and detailed procedure for a new finished amplifier slab shipping and storage container. The new package is designed to maintain an environment of <5% RH to minimize weathering.

Discussion
In order to protect the slabs from weathering and to minimize the LLNL cleaning process, a new amplifier slab-packaging scheme is being implemented. A schematic of the new package is shown in Fig. 1, which illustrates the basic components of package.

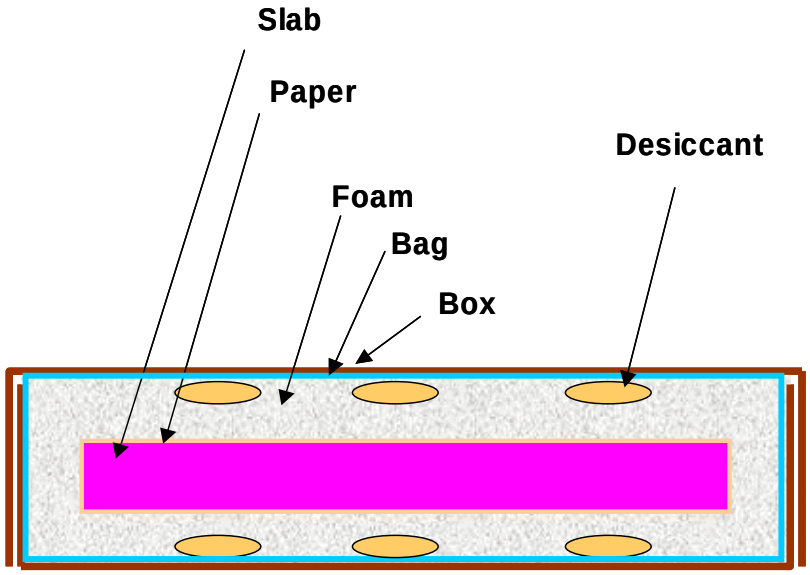


Figure 1. Simple schematic illustrating the basic components of new amplifier slab shipping package.

The new packaging route now utilizes desiccant and a more moisture-impermeable bag to ensure a dry environment around the slab. Also, the new packaging scheme does not use Opticlean on the slab surface. This is because residue on the surface upon Opticlean removal requires cleaning processes (e.g., basic soap and ultrasonics), which have been shown to be detrimental to the slab surface.

The details of the new packaging procedure are outlined in the Appendix. Basically, the slab shall be wrapped in filter paper, then placed into the foam insert. Desiccants will be placed on the outside of the foam and a bag will be sealed over the slab, foam and desiccants. The bag shall be then placed in the cardboard box, strapped and placed in the supplied wooden crates.

A list of components in the slab package is listed in Table 1. Any change in the vendor source or product number of packaging materials requires prior approval by LLNL.

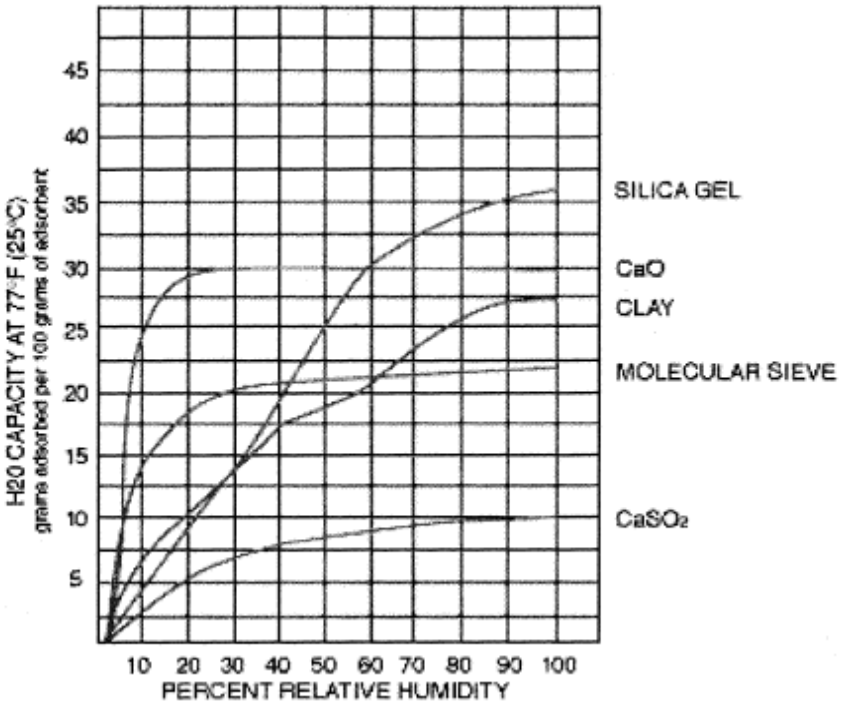
Table 1. Description of components certified for use in slab package.

	Component	Material	Supplier	Description
1	Paper	Brown kraft paper (non tarnishing)	Conifer Crent Company	20”x30” (500 sheets to a package); 22604KO
2	Cleanroom tape	Polyethylene (zero residue, light tack)	Ultratape Industries	½” and 2’’ Ultratape #1110
3	Foam	Polyethylene (Celluplank 220)	Midland Packaging and Coating	2.2 lbs/ft^3 –closed cell extruded
4	Bag	Multilayer Polymer over Al (HD-300)	Pactech	29” x 49” x 8”
5	Desiccant	Molecular sieves (4 Å pore size) (Hi-Dry) in Tyvek bags	Multisorb Technologies, Inc.	8 oz bags. 6 per slab package
6	Box	Cardboard	Midland Packaging and Coating	60 cm x 94 cm x 16.5 cm (OD)

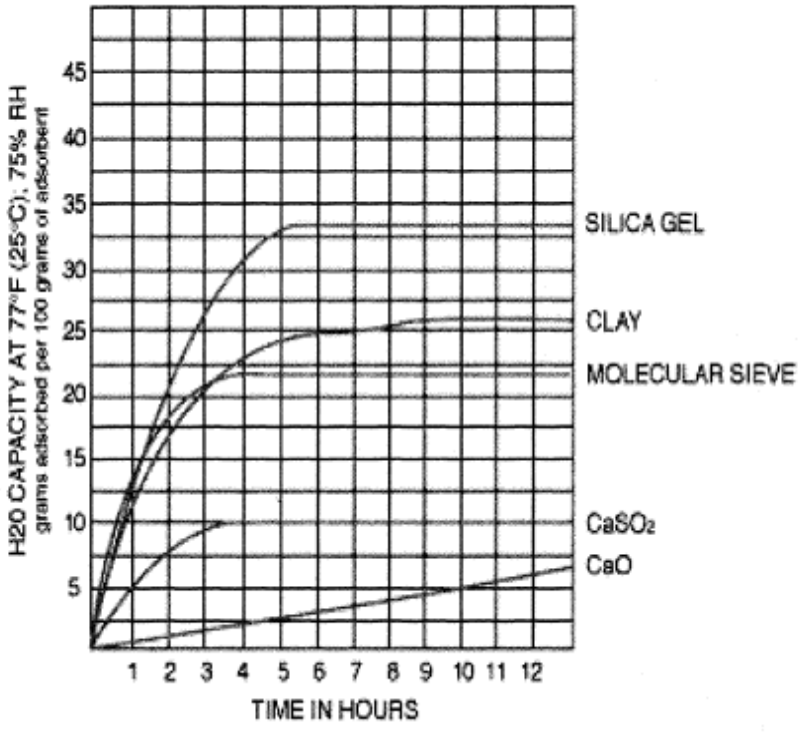
The type of desiccant used in the package is molecular sieves, chosen over other desiccants (such as silica gel, CaO, $MgClO_4$) because it is commercially available and because it has a low equilibrium vapor pressure for water (1.1% RH) (see Fig. 2a) [1]. The goal of the package is to maintain an environment of less than 5% RH. At 5% RH, the slab should survive ~25 years before it starts to weather [2]. An environment lower than 5% RH will be maintained as long as the water content in the desiccant is less than 7.5 wt% H_2O (see Fig. 2a). Note we are assuming transport of all moisture in the sealed bag to the desiccant is relatively fast. It turns out that the closed cell foam is a very good moisture barrier[3]. Hence holes have been drilled in the foam between the slab and the desiccant to increase transport.

The foam, filter paper, and cardboard all have water in them. Under ambient conditions (room temperature, 50% RH), the foam has 0.11% water[4], the filter paper has 3.1 % water[5], and the cardboard has ~4%[6]. The filter paper and foam will be in the bag with the slab, hence using the weights of the foam and paper used the bag will have ~12 gms water[7]. Hence a 160 gm of desiccant is the minimum amount needed to maintain 5

%RH. Using a safety factor of ~8.5, we have decided to use 1360 gms (or 6 eight oz bags) of desiccant. With this design, ~116 gm of water would have to permeate through the bag before the RH would go above 5%. The bag is rated to have a zero permeability to water vapor. However, testing time limitations limit the reliability of the reported value and we decided to place additional desiccant in the package as a safety factor. This will also compensate for the fact that the desiccant will not be absolutely dry, as-received. The specification is ≤2 wt% water in the desiccant. Assuming that all the desiccant is at the 2 wt% water level, then the safety factor is approximately 6.



(a)



(b)

Figure 2. (a) Isotherms for various desiccants; (b) Rate of H_2O adsorption for various desiccants (Courtesy Multisorb Technologies, Inc.)

Appendix: Detailed Procedure for Packaging Amplifier Slabs (Draft)

1. Securely wrap slab in brown kraft paper (~20 sheets); visually verify there are no tears or perforations. This operation should be performed with the operator using latex gloves to prevent skin oils interacting with the paper and slab surface. Use the ½" cleanroom tape to secure the filter paper in place.

2. Remove foam components in customer-supplied cardboard box. Separate the two-ply foam components such that the two-ply foam component has desiccant compartments facing out.

3. Open desiccant drum and remove one six-pack foil container, which contains six desiccant packages. Re-seal the desiccant drum with lock ring to avoid moisture contamination.

4. Open foil package. Visually inspect that no packages are broken open.

5. Remove three desiccant bags and place in the desiccant compartment in the two-ply foam insert.

6. Use the 2" cleanroom tape to hold the desiccant packages in place. This shall be done by applying one vertical strip over the edge of the foam down across the desiccant packages and extending approximately three inches over the opposite end.

7. Turn over the foam insert such that the slab cavity is exposed and ready to receive the slab. Visually inspect and make sure there is no foreign material inside the cavity.

8. Manually transfer the kraft paper-wrapped slab into the foam cavity.

9. Place foam cover over the slab with desiccant cavities facing up.

10. Remove the three remaining desiccant packages from the aluminum package and place them in the three desiccant cavities. Use the 2" white tape to tape in place these three packages in the same fashion as in Step 6. The clean room tape should extend over the ends of the foam packaging such that it holds the top foam insert firmly in place.

11. Transfer the slab to the ULOT using the current standard procedure. Pull the bag over the foam packaging including the lower arms of the ULOT. Now carefully transfer the slab and foam container from the ULOT on to the packaging table.

12. Verify the foam container has reached the end of the bag. Visually verify that the bag is free of any breaks or perforations.

13. Position the slab for bag sealing.

14. Proceed to seal the bag using standard pump-down, nitrogen purge and bag sealing procedures. The recommended sealing parameters are 375^{o}F, 40 psi for 3 seconds.

15. Once the bag is sealed, the total time duration from start of packaging procedure shall not have exceeded 20 minutes. The issue is exposure of the desiccant bags to moisture; it should be minimized.

16. Using the 2" cleanroom tape, neatly tape in place any excess bag material.

17. Place 2" cleanroom tape over any staples exposed on the interior of cardboard box.

18. Carefully transfer the wrapped slab and packaging into the cardboard box supplied for that purpose.

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[1] R. Steele, "Test of various desiccants in the laser slab bag', NIF0086408 (August 8, 2002).
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